CLAIMS

1. A method of restarting a temperature swing adsorption (TSA) apparatus which purifies feed air for a cryogenic air separation plant, comprising:

in the case where the TSA apparatus was stopped when or after when a temperature of a purge gas which flows out from a first adsorption column during a regeneration process became a peak temperature in the regeneration process,

in the first adsorption column during the regeneration process, closing, at the time of stopping the TSA apparatus, an entrance valve, an exit valve, and an atmosphere-releasing valve;

in a second adsorption column during an adsorption process, closing an entrance valve and an exit valve and opening an atmosphere-releasing valve so as to release a gas in the opposite direction to feed air flow, followed by closing the atmosphere-releasing valve;

pressurizing, just before a restart, the second adsorption column with the feed air to a pressure necessary for the adsorption process; and

performing, after the restart, the regeneration process in the first adsorption column and the adsorption process in the second adsorption column continuously from the time point of stopping the TSA apparatus.

2. A method of restarting a TSA apparatus according to claim 1, wherein the feed air which is fed to the TSA apparatus has a temperature of 5°C to 45°C and a pressure of 400 to 1,000 kPa (absolute pressure).

3. A method of restarting a temperature swing adsorption (TSA) apparatus which

purifies feed air for a cryogenic air separation plant, comprising:

in the case where an elapsed time t_1 of a regeneration process at the time point of stopping the TSA apparatus satisfies the following formula in a first adsorption column during the regeneration process,

$$t_1 < t_2 - (R_1 / R_2) \times (t_2 - t_3)$$

t_1: the elapsed time of the regeneration process (min)

t_2: a time of the regeneration process (min)

t_3: a time of a pressurizing step (min)

R_1: a flow rate of a purge gas (Nm^3/hour)

R_2: a flow rate of the feed air (Nm^3/hour)

in the first adsorption column during the regeneration process, closing, at the time of stopping the TSA apparatus, an entrance valve, an exit valve, and an atmosphere-releasing valve;

in a second adsorption column during an adsorption process, closing an entrance valve and an exit valve and opening an atmosphere-releasing valve so as to release a gas in the opposite direction to feed air flow, followed by closing the atmosphere-releasing valve;

pressurizing, just before a restart, the second adsorption column with the feed air to a pressure necessary for the adsorption process;

performing, after the restart, the regeneration process in the first adsorption column and the adsorption process in the second adsorption column from the beginning of each process while blocking purified air flow from the TSA apparatus to an air separation section; and

starting to feed purified air to the air separation section.

4. A method of restarting a TSA apparatus according to claim 3, wherein the adsorption process is performed with the flow rate of the feed air corresponding to the flow rate of the purge gas necessary for the regeneration process of the adsorption column after the restart before starting to feed the purified air to the air separation section.

5. A method of restarting a TSA apparatus according to claim 3, wherein the feed air which is fed to the TSA apparatus has a temperature of 5°C to 45°C and a pressure of 400 to 1,000 kPa (absolute pressure).

6. A method of restarting a temperature swing adsorption (TSA) apparatus which purifies feed air for a cryogenic air separation plant, comprising:

in a first adsorption column during a regeneration process, closing, at the time of stopping the TSA apparatus, an entrance valve, an exit valve, and an atmosphere-releasing valve;

in a second adsorption column during an adsorption process, closing an entrance valve and an exit valve and opening an atmosphere-releasing valve so as to release a gas in the opposite direction to feed air flow, followed by closing the atmosphere-releasing valve;

pressurizing, just before a restart, the second adsorption column with the feed air to a pressure necessary for the adsorption process;

performing, after the restart, the regeneration process in the first adsorption column and the adsorption process in the second adsorption column from the time point of stopping the TSA apparatus and then switching the processes to perform the adsorption process in the first adsorption column and the regeneration process in the

second adsorption column once while blocking purified air flow from the TSA apparatus to an air separation section; and

starting to feed purified air to the air separation section.

7. A method of restarting a TSA apparatus according to claim 6, wherein the adsorption process is performed with the flow rate of the feed air corresponding to the flow rate of the purge gas necessary for the regeneration process of the adsorption column after the restart before starting to feed the purified air to the air separation section.

8. A method of restarting a temperature swing adsorption (TSA) apparatus which purifies feed air for a cryogenic air separation plant, comprising:

distinguishing the time point of stopping the TSA apparatus in the following three cases i), ii), and iii):

i) a case in which the TSA apparatus was stopped when or after when a temperature of a purge gas which flows out from a first adsorption column during a regeneration process became a peak temperature in the regeneration process,

ii) a case in which an elapsed time t_1 of the regeneration process at the time point of stopping the TSA apparatus satisfies the following formula in the first adsorption column during the regeneration process, and

$$t_1 < t_2 - (R_1 / R_2) \times (t_2 - t_3)$$

t_1: the elapsed time of the regeneration process (min)

t_2: a time of the regeneration process (min)

t_3: a time of a pressurizing step (min)

R_1: a flow rate of the purge gas (Nm^3/hour)

R_2: a flow rate of the feed air (Nm^3/hour)

iii) a case other than the cases i) and ii);

in the case i), in the first adsorption column during the regeneration process, closing, at the time of stopping the TSA apparatus, an entrance valve, an exit valve, and an atmosphere-releasing valve,

in a second adsorption column during an adsorption process, closing an entrance valve and an exit valve and opening an atmosphere-releasing valve so as to release a gas in the opposite direction to feed air flow, followed by closing the atmosphere-releasing valve,

pressurizing, just before a restart, the second adsorption column with the feed air to a pressure necessary for the adsorption process, and

performing, after the restart, the regeneration process in the first adsorption column and the adsorption process in the second adsorption column continuously from the time point of stopping the TSA apparatus;

in the case ii), in the first adsorption column during the regeneration process, closing, at the time of stopping the TSA apparatus, the entrance valve, the exit valve, and the atmosphere-releasing valve,

in the second adsorption column during the adsorption process, closing the entrance valve and the exit valve and opening the atmosphere-releasing valve so as to release the gas in the opposite direction to the feed air flow, followed by closing the atmosphere-releasing valve,

pressurizing, just before the restart, the second adsorption column with the feed air to the pressure necessary for the adsorption process,

performing, after the restart, the regeneration process in the first adsorption column and the adsorption process in the second adsorption column from the beginning

of the each process while blocking purified air flow from the TSA apparatus to an air separation section, and

starting to feed purified air to the air separation section; and

in the case iii), in the first adsorption column during the regeneration process, closing, at the time of stopping the TSA apparatus, the entrance valve, the exit valve, and the atmosphere-releasing valve,

in the second adsorption column during the adsorption process, closing the entrance valve and the exit valve and opening the atmosphere-releasing valve so as to release the gas in the opposite direction to the feed air flow, followed by closing the atmosphere-releasing valve,

pressurizing, just before the restart, the second adsorption column with the feed air to the pressure necessary for the adsorption process,

performing, after the restart, the regeneration process in the first adsorption column and the adsorption process in the second adsorption column from the time point of stopping the TSA apparatus and then switching the processes to perform the adsorption process in the first adsorption column and the regeneration process in the second adsorption column once while blocking the purified air flow from the TSA apparatus to the air separation section, and

starting to feed the purified air to the air separation section.

9. A method of restarting a TSA apparatus according to claim 8, wherein in the cases ii) and iii), the adsorption process is performed with the flow rate of the feed air corresponding to the flow rate of the purge gas necessary for the regeneration process of the adsorption column after the restart before starting to feed the purified air to the air separation section.